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OBSERVATIONS ON THE INHERITANCE OF ANTHOCYAN PIGMENT IN PADDY VARIETIES

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Economic Botanist to the Government of Bengal

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OBSERVATIONS ON THE INHERITANCE OF ANTHOCYAN PIGMENT IN PADDY VARIETIES.

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[Received for publication on the 27th December, 1915.]

A considerable proportion of paddy varieties are characterized by the presence of reddish and purplish anthocyan pigment distributed throughout various parts of the plant. The varieties so far studied at Dacca may, with reference to the distribution of the pigment, be broadly classified as follows :—

(1) Leaf-sheaths, apiculus of the glumes, and stigma coloured.

(2) Leaf-sheath and apiculus of glumes coloured, but stigma colourless (white).

(3) Apiculus of glumes and stigma coloured, but leaf-sheaths colourless.

(4) Apiculus of glumes only coloured.

Class 1 is the commonest group—2, 3 and 4 containing comparatively few members.

The colours concerned range from red through purples to almost black, and it is noteworthy that in some of these coloured types the colour in the stigma is a darker shade than the colour in the leaf-sheath and apiculus, and, as will be shown below, appears to contain in such cases additional colour factors not present in the leaf-sheath and apiculus.

It is somewhat doubtful if classes 3 and 4 really exist. The apparent absence of colour in the leaf-sheath in these cases may, as is suggested by

Graham[1] with reference to the Central Provinces' varieties, perhaps be due to the fact that the colour is of so faint and fleeting a nature as to escape detection, more especially so as the intensity of the colour appears to be considerably affected by environmental conditions. Moreover, all paddies so far examined which have a coloured leaf-sheath seem also to have a coloured apiculus, and as Graham[1] states, the converse may also be true, as the colour in the leaf-sheath and apiculus seems to be the same and behaves in inheritance as if due to the same factors.

The colour in the stigma, on the other hand, does not always correspond with the leaf-sheath and apiculus colour. It may be colourless, though colour is present in the leaf-sheath and apiculus, or it may be of the same colour as the leaf-sheath and apiculus, or it may be of a darker shade. The colour in the leaf-sheath can generally be detected in the cotyledonary leaf of the young seedling, if fully exposed to sunlight (*cf.* Plate I, fig. 1), and counts of this character can be made in seedlings of a few days old.

The following observations on the inheritance of these colours have been made incidental to work of a more practical nature. Their complete elucidation will involve a long series of analyses extending over some length of time, but the results so far obtained show that their inheritance is on the same lines as have been proved to hold in the case of *Lathyrus*, *Matthiola*, *Antirrhinum* and *Primula* investigated by Bateson, Punnett, Saunders,[2] Wheldale,[3] Gregory[4] and others. The results quoted have mostly been obtained from the analysis of the offspring of natural crosses, but some results from artificial crosses, so far as available up to date, are also included.

(1) *The* 9 : 7 *ratio in the leaf-sheath.*

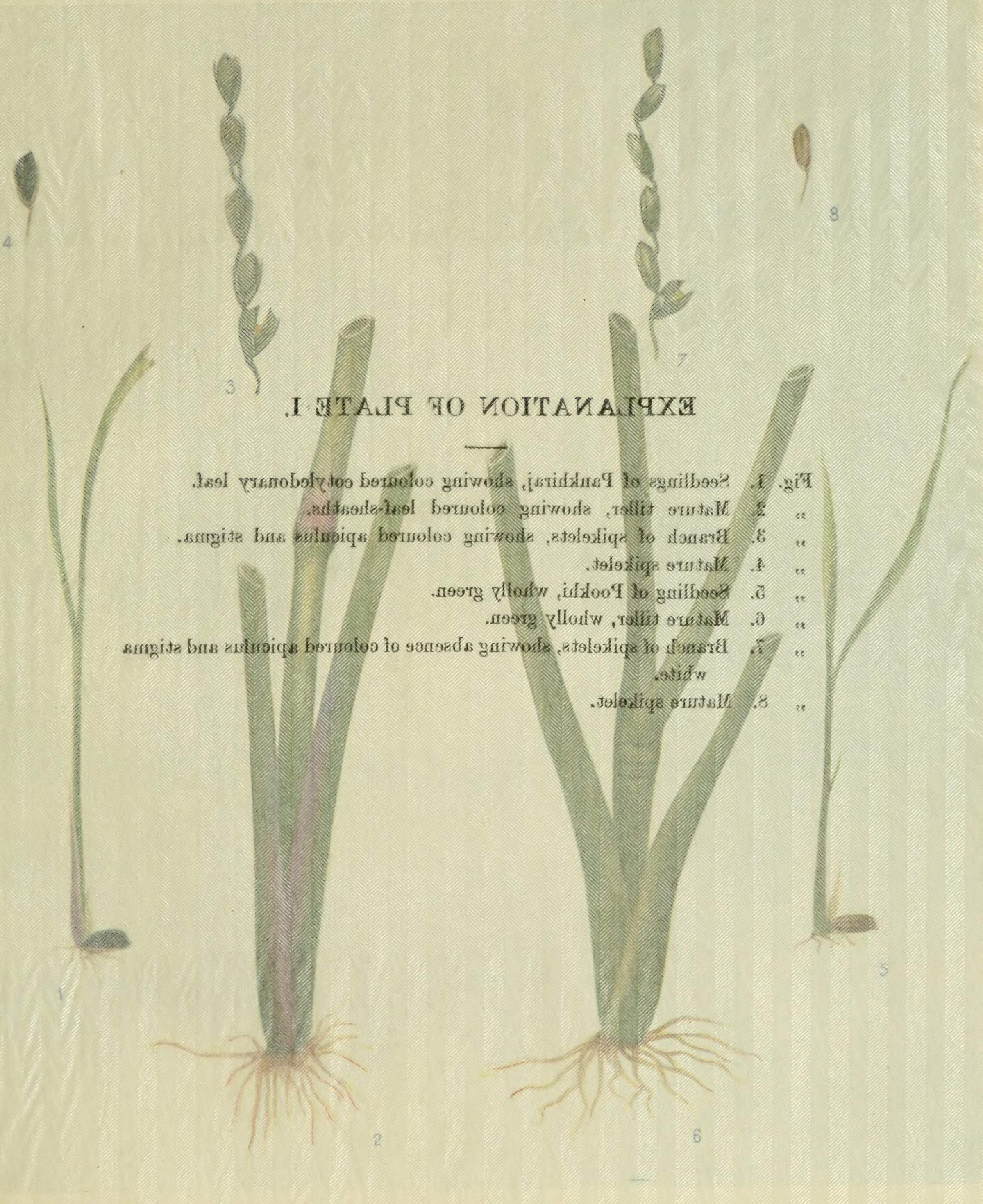
In the season of 1912, forty-eight natural crosses characterized by the presence of red pigment in the leaf-sheaths were found in our pure line plots, and in 1913 these all split in the seed-beds into various coloured reds and green, the total number of the reds to the green being 12,122 to 9,007, a close approximation to the now well-authenticated Mendelian ratio 9 : 7, the expectation

[1] Graham, R. J. D. Preliminary Note on the Classification of Rice in the Central Provinces. *Memoirs, Department of Agriculture, India, Botanical Series*, vol. VI, no. 7, 1913.

[2] Bateson, W., Saunders, E. R., and Punnett, R. C. *Reports to Evolution Com. Roy. Soc.*, III, 1906, page 31.

[3] Wheldale, M. Inheritance of Flower Colour in *Antirrhinum majus*, *Proc. Roy. Soc.*, 79 B., 1907, page 288, etc.

[4] Gregory, R. P. Experiments with *Primula sinensis*, *Journal of Genetics*, I, no. 2, March 1911, pages 94—124.



Figs. 1-4. VAR. PANKHIRAJ.

Figs. 5-8. VAR. POOKHI.

EXPLANATION OF PLATE I.

Fig. 1. Seedlings of Pankhiraj, showing coloured cotyledonary leaf.

„ 2. Mature tiller, showing coloured leaf-sheaths.

„ 3. Branch of spikelets, showing coloured apiculus and stigma.

„ 4. Mature spikelet.

„ 5. Seedling of Pookhi, wholly green.

„ 6. Mature tiller, wholly green.

„ 7. Branch of spikelets, showing absence of coloured apiculus and stigma white.

„ 8. Mature spikelet.

Figs. 1-4. VAR. PANKHIRAJ.

Figs. 5-8. VAR. POOKHI.

on this basis being 11,885·1 to 9,243·9. Two to three hundred seedlings from each of forty-five of these seed-beds were transplanted at random in the field and in the same year subsequent counts of the mature plants gave 6,265 reds : 4,846 green, the expectation being 6,249·94 : 4,861·06, a still closer approximation to the 9 : 7 ratio.

In the years 1913 and 1914 detailed counts were also made in the field of 10 plots raised from similarly coloured natural crosses selected for their colour characters in 1912 and 1913, and the results are tabulated below :—

Table I.

Serial No.	Leaf-sheath red, Apiculus red	Leaf-sheath green, Apiculus green	Expectation
No. 20, 1913	106	76	102·4 : 79·6
,, 22, 1914	63	49	63·0 : 49·0
,, 23, ,,	58	60	66·4 : 51·6
,, 24, ,,	58	49	60·2 : 46·8
,, 25, ,,	57	56	63·6 : 49·4
,, 29, ,,	80	34	64·2 : 49·8
,, 39, ,,	70	43	63·6 : 49·4
,, 57, ,,	81	13	52·9 : 41·1
,, 30, ,,	75	39	64·2 : 49·8
,, 64, ,,	23	12	19·7 : 15·3
Total	671	431	719·9 : 482·1

Adopting the notation employed by Bateson, Saunders and others, if R be considered the factor which in presence of a chromogen base C produces the red colour, then the simplest explanation of these cases is to suppose that the coloured parent was of the constitution CR and the green (colourless) cr. The F_1 hybrid will then have the constitution RrCc, and on selfing will give rise to plants of the following constitutions :—

9RC—red,
3Rc—green,
3Cr—green.
1cr—green,
i.e. 9 red : 7 green.

On this hypothesis, it is seen there will be four kinds of reds, *viz.* : RRCC RrCc, RrCC, RRCc. No attempt has so far been made to sort out the different shades of red, but it is undoubted that various shades of red do occur in the F_2.

In reality, however, as will be seen from further examples discussed below, the constitution of the parents may have been much more complicated.

(2) *Examples of* 3 : 1 *ratios.*

In a few cases the simple 3 : 1 ratio has been obtained. An example of this was afforded by the heterozygous type Ba 1, noted in a former paper,[1] picked from a variety named Gobrabali in 1911. The parent had a red apiculus to the glumes, red awns and a coloured stigma, and in 1912 split into

1. Red awns, glumes with red apiculus, coloured stigma, 73,
2. White awns, glumes with green apiculus, white stigma, 23,

giving a ratio 3·17 coloured : 1 colourless. Here the colour in apiculus, awns and stigma behaves as a single unit and may perhaps be due to the same simple factor or to the same interacting factors. If the latter, the simplest explanation would be to suppose the parent heterozygous for one of the factors, *i.e.*, of the constitution RrC or RCc.

Five of these coloured plants selected in 1912 again split in 1913 in the proportions shown below :—

TABLE II.

1913 Plot No.	Coloured awns, apiculus and stigma	White awns, green apiculus, white stigma	Ratio
77	91	23	3·9 : 1
78	155	56	2·7 : 1
79	129	43	3·0 : 1
80	188	72	2·6 : 1
81	126	45	2·8 : 1
82	122	40	3·05 : 1
83	108	45	2·4 : 1
84	126	47	2·6 : 1
85	85	26	3·2 : 1
Total	1,130	397	2·8 : 1

[1] Hector, G. P. Notes on Pollination and Cross-fertilization in the Common Rice Plant, *Oryza sativa*, Linn. *Memoirs, Dept. of Agri., India, Bot. Series*, vol. VI, no. 1, 1913.

Another case of red colour giving the 3 : 1 ratio affected the apiculus of the glumes only. A hybrid parent with red apiculus to the glumes but no apparent colour elsewhere selected in 1912, gave in 1913, 75 plants with red apiculus : 25 with no apiculus.

The above cases are all from natural crosses. In 1913 several artificial crosses were made between a wholly green variety (Pookhi, Plate I, figs. 5–8) and a variety with marked reddish colour in the leaf-sheath and glume-apex, and a purple colour in the stigma (Pankhiraj, Plate I, figs. 1–4). The F_1 plants (1914) showed the colour characters almost wholly dominant.

In 1915 the following results were obtained with reference to colour characters :—

	Coloured leaf-sheath, apiculus and stigma	Colourless	Ratio
No. 1 Pookhi ♀ × Pankhiraj ♀	67	30	2·2 : 1
,, 2 ,, ,,	200	67	2·9 : 1
,, 3 ,, ,,	267	69	3·8 : 1
,, 4 ,, ,,	116	30	3·8
,, 5 Pankhiraj ♀ × Pookhi ♀	365	121	3·01 : 1
Total	1,015	317	3·2 : 1

Here, again, the colour in the leaf-sheath, apiculus and stigma behaves as a single unit and may be due to one simple factor ; or it is necessary to suppose that the green parent possessed one of the factors necessary for the production of colour, but was lacking in the other, *i.e.*, that the cross is of the nature RC × rC or Rc.

(3) *Purple colour in the stigma due to three interacting factors.*

It has been noted above that in some of our types with colour in the leaf-sheath, apiculus and stigma, the colour in the leaf-sheath and apiculus is some shade of red, while that in the stigma is a deeper purple. Graham[1] states with reference to the coloured varieties in the Central Provinces that where the stigma is coloured, the colour of the stigma corresponds with the colour in the leaf-sheaths ; those with red leaf-sheath having a red stigma, those with bluish or purplish leaf-sheath having a blue or purple stigma.

[1] Graham, *loc. cit.*

We have not found this to be the case in all our types, many having some shade of red in the leaf-sheath, but a blue-black colour in the stigma, and the evidence quoted below proves that in some of these cases this purple stigma colour appears to be due to the interaction of three factors, and furthermore that the simultaneous presence of all three appears necessary for the production of colour at all.

The cases discussed here with reference to the stigma colour are the same as those quoted above (Table I) in which the leaf-sheaths gave the 9 : 7 ratio. The parents, selected in 1912 and 1913, had reddish coloured leaf-sheaths, red apiculus and blue-black stigmas, and in 1913 and 1914 gave the results below :—

Table III.

Serial No.	Leaf-sheath red, apiculus red, stigma coloured of various shades	Leaf-sheath red, apiculus red, stigma white	Leaf-sheath green, apiculus green, stigma white	Coloured stigma : White stigma	Expectation
22, 1914	44	19	49	44 : 68	47·2 : 64·8
23, ,,	42	16	60	42 : 76	49·7 : 68·3
24, ,,	40	18	49	40 : 67	45·1 : 61·9
25, ,,	46	11	56	46 : 67	47·6 : 65·4
29, ,,	47	33	34	47 : 67	48·09 : 65·91
39, ,,	42	28	43	42 : 71	47·5 : 65·1
57, ,,	14	67	13	14 : 80	39·6 : 54·4
20, 1913	78	28	76	78 : 104	76·7 : 105·3
30, 1914	62	13	39	62 : 52	48·09 : 65·91
64, ,,	22	1	12	22 : 13	14·7 : 20·3
Total	437	234	431	437 : 665	465·7 : 638·3

If we again adopt the usual notation for such cases, the above results could be produced by supposing that (1) the colour in the leaf-sheath and apiculus is due to a colour factor R acting on a Chromogen base C, (2) that the purple colour of the stigma is due to a further factor P not present in the leaf-sheath and apiculus, and (3) that the simultaneous presence of all three factors RCP is necessary for the production of colour of any sort in the stigma.

If this explanation is correct, then the constitution of the F_1 plants with reference to the stigma must be Cc Rr Pp and these on selfing will give rise to :—

(1)	27 plants of constitution	CRP—	coloured stigma,	red leaf-sheath,	red apiculus.
(2)	9 ,, ,,	CR—	white ,,	,,	,,
(3)	9 ,, ,,	PR—	,, ,,	green leaf-sheath and apiculus.	
(4)	9 ,, ,,	CP—	,, ,,	,,	,,
(5)	3 ,, ,,	R—	,, ,,	,,	,,
(6)	3 ,, ,,	C—	,, ,,	,,	,,
(7)	3 ,, ,,	P—	,, ,,	,,	,,
(8)	1 ,, ,,	crp—	,, ,,	,,	,,

i.e., 27 coloured : 37 white stigmas or 1 : 1·3.

The interesting point in these cases lies in the fact that the 9 plants of constitution CR would normally be expected to have stigmas of a reddish colour like the leaf-sheaths, as both the factors necessary for the production of red colour in the leaf-sheath and apiculus are present here in the stigma, the purple factor P only being absent, but in not a single case could a trace of colour be found in these. What the explanation of this is has not yet been determined. A possible explanation is that there is here some factor in the stigma which inhibits the production of the colour, except when the additional factor P is present. If so, then these white stigmas of the constitution CR should prove dominant over similarly constituted red stigmas amongst coloured types. Amongst the coloured stigmas, it was possible to detect various shades, some apparently red, but no attempt has yet been made to separate these. This also would explain the occasional occurrence of pure-breeding types with coloured leaf-sheaths, apiculus and white stigma, the second class referred to in the beginning. Such types may have been produced through the agency of natural crossing and some may prove to be dominant whites. If so, then these cases would seem to be comparable to the red-stemmed, dominant white flowers described by Gregory[1] in the case of Primulas.

Assuming this explanation, in the F_3 generation out of every 27 coloured stigmas,

1	should produce	coloured only.
6	,, ,,	3 coloured : 1 white.
12	,, ,,	9 coloured : 7 white.
8	,, ,,	27 coloured : 37 white.

and it should also be possible to produce the colour by inter-crossing many of the whites.

[1] Gregory, *loc. cit.*, p. 115.

(4) *Colour due to three and four interacting factors.*

The cross discussed below was made in the season 1912 between a wholly green, awnless variety with white stigma, Chittagong No. 25 (Plate II, figs. 5–8), and a variety with reddish purple leaf-sheaths, apiculus and awns, and a deep blue-black stigma, Chittagong No. 9 (Plate II, figs. 1-4). Four successful crosses were obtained, but unfortunately during the absence of the writer on tour, three of the F_1 plants were eaten by insects and the result of only one, C25 ♀ × C9 ♀ are so far available. The cross has since been repeated, but the results will not be forthcoming for another year.

In the F_1 the colour characters appeared to be almost wholly dominant, though the colours were not quite so pronounced as in the coloured parent. Five hundred and twenty-nine plants were bred to the F_2 generation during the season 1914 and gave the following figures with reference to colour characters :—

(1) Red leaf-sheaths ; red apiculus ; coloured stigma		.. 180	} 250 (1)+(2)
(2) ,, ,, white stigma		.. 70	} 349 (2)+(3)
(3) Green leaf-sheaths ; green apiculus ; ,,		.. 279	
i.e., coloured leaf-sheath and apiculus	250 : green	.. 279	
Expectation	223·1 :	.. 305·9	
Coloured stigma	180 : white	.. 349	
Expectation	167·3 :	.. 361·7	

Confirmation of the above figures has also been obtained from the analysis of the offspring of a natural hybrid selected from the pure line plot of Chittagong No. 9 in 1914, only in this example the male parent is unknown. In the present season 1915 the following figures were obtained :—

(1) Red leaf-sheath ; red apiculus ; coloured stigma		.. 28	} 47 (1)+(2)
(2) ,, ,, white stigma		.. 19	} 71 (2)+(3)
(3) Green leaf-sheath ; green apiculus ; white stigma		.. 52	
i.e., coloured leaf-sheath and apiculus	47 : green	.. 52	
Expectation	41·7 :	.. 57·3	
Coloured stigma	28 : white	.. 71	
Expectation	31·3 :	.. 67·7	

Here the figures closely approximate to the expectation on a basis of three interacting factors for the leaf-sheath and apiculus colour, and four for the stigma, otherwise this case is exactly comparable to those in Table III, and the constitution of the F_2 types will be as under, using B for the extra colour factor in the stigma :—

81—CRPB—Coloured leaf-sheath, apiculus and stigma.

27—CRPb— ,, ,, , stigma white.

PLATE II.

Figs. 1-4. CHITTAGONG No. 9.

EXPLANATION OF PLATE II.

Fig. 1. Seedling of Chittagong 9, showing coloured cotyledonary leaf.
„ 2. Mature tiller, showing coloured leaf-sheaths.
„ 3. Branch of spikelets, showing coloured apiculus and stigma.
„ 4. Mature spikelet.
„ 5. Seedling of Chittagong 25, wholly green.
„ 6. Mature tiller, wholly green.
„ 7. Branch of spikelets, showing no coloured apiculus and stigma white.
„ 8. Mature spikelet.

Figs. 1-4. CHITTAGONG No. 9.

Figs. 5-8. CHITTAGONG No. 25.

27—CRBp—Green leaf-sheath,	apiculus,	stigma white.	
27—cRPB—	,,	,,	,,
27—rCPB—	,,	,,	,,
9—pbCR—	,,	,,	,,
9—rbPC—	,,	,,	,,
9—rpBC—	,,	,,	,,
9—cbRP—	,,	,,	,,
9—crPB—	,,	,,	,,
9—pcBR—	,,	,,	,,
3—rpbC—	,,	,,	,,
3—cpbR—	,,	,,	,,
3—rcbP—	,,	,,	,,
3—crpB—	,,	,,	,,
1—rcpb—	,,	,,	,,

Assuming the previous explanation, in this case, as well as dominant white stigmas, there should also be found greens amongst the types with green leaf-sheath and apiculus dominant over red coloured leaf-sheaths among coloured types, and it should be possible to produce colour in the leaf-sheath by inter-crossing many of the greens. Such green types are really coloured but by virtue of their containing some inhibiting factor or factors which prevent the appearance of the colour except when all the colour factors are present, the colour is not produced, and the result is a plant with a green leaf-sheath.

Amongst the 81 plants with coloured stigmas there will be stigmas of 16 different constitutions, which should in the F_3 produce coloured : colourless in the proportions below, *viz.*,

1	should produce all coloured.				
8	,,	3 coloured	:	1 white.	
24	,,	9 ,,	:	7	,,
32	,,	27 ,,	:	37	,,
16	,,	81 ,,	:	175	,,

Amongst the 16 differently constituted stigmas, there should be also a considerable range of colour and it was possible without much difficulty to make out 4 main classes, *viz.*, blue-black, blue, reddish brown, and red.

The leaf-sheath colour, on the other hand, should behave in the F_3 in the same way as has already been pointed out above in the case of the stigma with three factors. All the coloured F_2 plants from the cross C 25 ♀ × C9 ♀ have been sown in the present season 1915, and the following table gives the

result for leaf-sheath colour in 107 F_3 plots picked at random from these. The figures again show a close approximation to the expectation on a basis of three interacting factors.

R : G 27 : 37. No. expected 32		R : G 9 : 7. No. expected 48		R : G 3 : 1 No. expected 24		Pure Red No. expected 4	
Plant No. 1914	1915	Plant No. 1914	1915	Plant No. 1914	1915	Plant No. 1914	1915
2	92 : 103	3	38 : 26	12	173 : 54	27	Pure Red.
7	74 : 111	4	99 : 51	18	138 : 37	33	,,
10	74 : 100	5	102 : 78	21	153 : 32	39	,,
11	88 : 95	6	90 : 90	25	117 : 54	44	,,
15	74 : 80	8	95 : 91	28	148 : 47	46	,,
30	90 : 103	9	92 : 48	31	127 : 58	58	,,
37	28 : 77	13	62 : 61	38	112 : 48	91	,,
43	95 : 96	14	97 : 62	40	156 : 73	92	,,
57	78 : 100	16	163 : 144	41	112 : 32	106	,,
73	33 : 152	17	112 : 74	56	123 : 49	123	,,
76	87 : 101	19	91 : 68	59	134 : 34	125	,,
77	54 : 137	22	124 : 71	61	130 : 58		
79	75 : 116	23	102 : 95	62	105 : 48		
80	33 : 141	29	41 : 35	65	121 : 40		
81	66 : 86	35	109 : 67	78	129 : 60		
84	100 : 198	36	104 : 73	82	106 : 28		
88	67 : 133	42	103 : 76	83	135 : 55		
89	89 : 109	45	89 : 76	85	151 : 31		
94	84 : 86	47	98 : 80	93	139 : 60		
100	37 : 149	50	119 : 61	95	160 : 38		
103	85 : 91	52	101 : 89	96	140 : 31		
104	65 : 89	53	96 : 79	97	158 : 34		
105	99 : 100	57	77 : 76	99	152 : 63		
108	83 : 93	60	73 : 69	110	113 : 41		
112	85 : 91	63	98 : 87	111	60 : 24		
119	60 : 71	64	99 : 89	114	100 : 39		
		66	106 : 83	131	160 : 30		
		68	118 : 65	143	160 : 40		
		70	59 : 41				
		71	103 : 75				
		72	140 : 67				
		74	89 : 84				
		75	102 : 86				
		86	100 : 89				
		87	100 : 97				
		101	110 : 85				
		102	127 : 67				
		107	101 : 88				
		109	126 : 77				
		113	101 : 98				
		121	100 : 96				
		122	100 : 77				
Total 26 ...	1895 : 2808	42	4156 : 3191	28	3712 : 1238	11	
Expected 32	1984·07:2718·9	48	4132·7:3214·3	24	3712·5:1237·5	4	

As regards stigma colour, the numbers could be counted in only a few plots, owing to the short period of time in which it is possible to determine stigma colour accurately. Hence it has not been possible to verify the relative proportions in which the different types of splitting occur, but apparent examples of all the different ratios of coloured : white expected, *viz.*, 3 : 1, 9 : 7, 27 : 37, and 81 : 175 have been found, as shown below :—

1. Leaf-sheath pure red, stigma ratio 3 : 1.

Plant No. 27.

Leaf-sheaths and glume apex coloured, stigma coloured	129	
,, ,, ,, ,, white	49	
Expectation	133·5 44·5	

2. Leaf-sheath ratio 3 : 1, stigma 9 : 7.

Plant No. 31.

Leaf-sheath and glume apex coloured, stigma coloured	98	127
,, ,, ,, ,, white	29	
,, ,, green, ,, white	58	87
Expectation	104·06 34·74 46·2	138·8 80·9

Plant No. 110.

Leaf-sheath and glume apex coloured, stigma coloured	85	113
,, ,, ,, ,, white	28	
,, ,, green, ,, ,,	41	69
Expectation	86·6 28·9 38·5	115·5 67·4

Plant No. 12.

Leaf-sheath and glume apex coloured, stigma coloured	134	173
,, ,, ,, ,, white	39	
,, ,, green, ,, ,,	54	93
Expectation	127·6 42·7 56·7	170·3 99·4

Plant No. 83.

Leaf-sheath and glume apex coloured, stigma coloured	99	135
,, ,, ,, ,, white	36	
,, ,, green, ,, ,,	55	91
Expectation	106·8 35·7 47·5	142·5 83·2

Plant No. 85.

Leaf-sheath and glume apex coloured, stigma coloured	124	151
,, ,, ,, ,, white	27	
,, ,, green, ,, ,,	31	58
Expectation	102·3 34·2 45·5	136·5 79·7

Plant No. 40.

Leaf-sheath and glume apex coloured, stigma coloured ..	100	156
,, ,, ,, ,, white ..	56	
,, ,, green, ,, ,, ..	73	129
Expectation	128·8	171·8
	43·0	
	57·2	100·2

3. Leaf-sheath ratio 9 : 7, stigma 27 : 37.

Plant No. 16.

Leaf-sheath and glume apex coloured, stigma coloured ..	107	163
,, ,, ,, ,, white ..	56	
,, green, ,, ,, ..	144	200
Expectation	129·5	172·7
	43·2	
	134·3	177·5

Plant No. 64.

Leaf-sheath and glume apex coloured, stigma coloured ..	75	99
,, ,, ,, ,, white ..	24	
,, ,, green, ,, ,, ..	89	113
Expectation	79·3	105·8
	26·5	
	82·2	108·7

Plant No. 70.

Leaf-sheath and glume apex coloured, stigma coloured ..	40	59
,, ,, ,, ,, white ..	19	
,, ,, green, ,, ,, ..	41	60
Expectation	42·1	56·3
	14·2	
	43·7	57·9

Plant No. 101.

Leaf-sheath and glume apex coloured, stigma coloured ..	83	110
,, ,, ,, ,, white ..	27	
,, ,, green, ,, ,, ..	85	112
Expectation	82·2	109·7
	27·5	
	85·3	112·8

4. Leaf-sheath ratio 27 : 37, stigma 81 : 175.

Plant No. 2.

Leaf-sheath and glume apex coloured, stigma coloured ..	73	92
,, ,, ,, ,, white] ..	19	
,, ,, green, ,, ,, ..	103	122
Expectation	61·6	82·3
	20·7	
	112·7	133·4

Plant No. 10.

Leaf-sheath and glume apex coloured, stigma coloured ..	46	74
,, ,, ,, ,, white ..	28	
,, ,, green, ,, ,, ..	100	128
Expectation	55·05	73·5
	18·5	
	100·5	119·0

CONCLUSIONS.

The main conclusions to be derived from the above results are :—

1. The colours in the leaf-sheaths, glume apex and stigma of certain paddy varieties appear generally to be due to the interaction of several factors.

2. In certain cases the colour in the stigma is of a higher order than the colour in the leaf-sheath and glume apex, and is due to the presence of an extra factor not present in the leaf-sheath and glume apex.

3. Where the colour has been found to be due to the interaction of more than one factor, the simultaneous presence of all colour factors appears necessary for the production of colour at all.

DACCA,
December, 1915.

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